1390

1912

IMPERIAL BUREAU OF MYCOLOGY
13 JUL 1921

BULLETIN

OF THE

Agricultural Experiment Station

OF THE

UNIVERSITY OF TENNESSEE

RECEIVED
JUN 17 1912
B. P. I.
NEW ORLEANS
Laboratory
GRAIN STANDARDIZATION

NUMBER 95 JANUARY 1912

NOTES ON TOMATO DISEASES WITH RESULTS OF SELECTION FOR RESISTANCE

BY

S. H. ESSARY

KNOXVILLE, TENNESSEE

The Agricultural Experiment Station

OF THE UNIVERSITY OF TENNESSEE

BROWN AYRES, President

EXPERIMENT STATION COMMITTEE

BROWN AYRES — HARRIS BROWN

T. F. P. ALLISON — HUGH L. ANDERSON

TREASURER — JAMES MAYNARD

SECRETARY — WM. RULE

STATION OFFICERS

BROWN AYRES, President of the University
H. A. MORGAN, Director, Zoologist and Entomologist
S. M. BAIN, Botanist
C. A. MOOERS, Chemist and Agronomist
C. A. KEFFER, Horticulturist
M. JACOB, Veterinarian
C. A. WILLSON, Animal Husbandman
S. H. ESSARY, Assistant Botanist and Mycologist
G. M. BENTLEY Assistant Zoologist and Entomologist
MAURICE MULVANIA, Assistant Bacteriologist
E. C. COTTON, Assistant Entomologist
J. F. VOORHEES, Consulting Meteorologist
W. K. HUNTER, Assistant Chemist (Soil Investigations)
J. E. TOOMER, Assistant Chemist (Fertilizers and Feeds)
J. I. HARDY, Assistant in Chemistry (Soil Investigations)
W. A. CAMPBELL, Farm Foreman
S. M. SPANGLER, Assistant in Plot Work
J. E. CONVERSE, Assistant in Cooperative Experiments, Crossville
W. N. RUDD, Assistant in Cooperative Experiments, McMinnville
L. R. NEEL, Assistant in Cooperative Experiments, Nashville
S. A. ROBERT, Supt. West Tenn. Exp. Station, Jackson
F. H. BROOME, Librarian and Secretary
MISS RUBY FRANKLIN, Office Assistant
MISS MARGARET COOMES, Stenographer

The Experiment Station building, containing the offices and laboratories, and the plant house and part of the Horticultural Department, are located on the University campus, 15 minutes walk from the Custom House in Knoxville. The experiment farm, the barns, stables, dairy building, etc., are located one mile west of the University, on the Kingston Pike. The fruit farm is adjacent to the Industrial School and is easily reached by the Lonsdale car line. Farmers are cordially invited to visit the buildings and experimental grounds.

Bulletins of this Station will be sent, upon application, free of charge, to any farmer in the State.

NOTES ON TOMATO DISEASES WITH RESULTS OF SELECTION FOR RESISTANCE

INTRODUCTION

This bulletin contains a brief report of the progress made in the investigation of the so-called "blight" disease of tomatoes in Tennessee. It is written for the grower, and all technical terms and discussions of laboratory details have been omitted. The work is as yet incomplete; but it is thought best to publish at this time a short account of the investigation, with the conclusions arrived at concerning the question of blight, and a few simple recommendations to tomato growers of the section where the experiments are being conducted. A complete report will be published in another bulletin when the work is finished, in which, it is hoped, a life-history of the fungus and a full bibliography of the literature on tomato diseases can be given. The main point in this publication is the announcement of the production of a blight-resistant strain of a commonly cultivated type of tomato.

TOMATO GROWING IN TENNESSEE

History Tomato growing for the market was introduced into Tennessee about twenty-five or thirty years ago. Since that time it has increased till in some sections of the State it is one of the most important industries. Gibson County has perhaps a larger area devoted to tomato growing than any other county in the State. The soil and climate seem peculiarly adapted to the development of the earlier types. They are grown either for canning factories or for shipping to distant markets. Canneries are usually located near tomato centers, and often they are the means of introducing tomato growing into a district. The growing of tomatoes for shipping to distant markets is necessarily limited to sections on main lines of railroad. Gibson County has three trunk lines reaching, by connections, the principal cities of the North. This county ships annually several hundred car loads of tomatoes to northern cities, from New York to St. Paul, and even into Canada.

Varieties Only the earlier varieties are suitable for this trade. The purple-red types of smooth exterior and medium size are the favorites in the markets mentioned. Such types as "Beauty," "Acme," and "Trucker's Favor-

ite" are very popular in the Gibson section. Several others of similar shape, size, and color are grown to a less extent. The types mentioned pack well, and stand shipping long distances. The "Beauty" is perhaps the most widely cultivated of these types. Other types are grown for canning, for which purpose shape, size and color are not so important.

Growing and marketing

Tomatoes ripen in the Gibson section just after the close of the shipping season in states further south, and before tomatoes begin to ripen north of the Ohio. This gives the section only a few weeks of open market, usually from about the middle of June till the first of August. After this time, it is not profitable to ship them. The earliest tomatoes shipped bring by far the best prices; hence, it is important to get the plants in the field and push them on to ripening as early as possible. To secure an early crop, it is necessary to sow the seed in hotbeds, and get the plants well advanced by the time frosts are over. The seed is sown in hotbeds about the middle of January, and the first transplanting, still in the beds, is made about a month later. The plants are allowed to grow here about a month longer; then they are transplanted a second time—this time into "dirt bands" in outside cold-frames—and covered with cloth or glass. They stand in the cold-frames till it is safe to put them out in the fields; then they are carried out in the dirt bands, placed about 30 inches apart, in rows varying from four to six feet apart. On the average, about 3500 to 4000 plants are put on one acre. At the time the plants are put out they are fairly well advanced, a few buds showing usually, and possibly a few flowers. They are trained to stakes, pruned to two main branches, and cultivated till the fruit begins to ripen. From five to nine "crops," or fruit clusters, are allowed to remain on a vine. Some growers top the vines, while others do not. Fertilizers are used liberally under the rows at the time of planting in the field. The quantity varies from 400 to 600 pounds of 8:2:2 or 8:2:4, or a similar grade of commercial fertilizer, to the acre.

ENEMIES OF THE TOMATO

Minor troubles

Of late years, many diseases have appeared in the Gibson tomato section. There is a damping off disease that appears in the beds after each transplanting that causes considerable loss. A leaf blight, caused by the fungus *Septoria lycopersici*, attacks the beds frequently, and may go with the plants to the field and do more or less damage. Various fruit rots are prevalent at ripening time. The tomato worm (*Heliothis armigera*), known also as the cotton boll worm and the corn ear worm, makes its appearance every few years in such numbers as to cause great damage by boring into

and ruining young fruit. In the season of 1911, it was unusually destructive throughout the tomato-growing sections of the State.

Blight

By far the worst of all tomato diseases is one known as "blight." This is not a new disease; it has been known in Florida and elsewhere for a number of years. It is believed to have been introduced into the Gibson district with hothouse plants brought from Florida. It was once the custom, and may be now to some extent, to bring young tomato plants from Florida instead of growing them at home. The disease has spread now till almost every farm in the Gibson district

FIG. 1.—A BLIGHTED FIELD

This ground was used for an experimental plot in 1911 (see Fig. 7). A considerable part of the crop was gathered before blight attacked this patch. Notice that the fruit still hangs on the vines although they are dead.—Pillow Farm, July 15, 1910.

has more or less blight. When it has once appeared in a field, it persists and spreads, especially if tomatoes are grown year after year on the same ground, until the whole field is worthless for further tomato growing, for a few years at least. It usually appears first in a few plants only; but in succeeding years it increases till the whole field is infected.

Symptoms of blight

The symptoms of the disease are well known to farmers and others who have made a close study of it. There is first a yellowing of the lower leaves. This is followed in a few days by the wilting and dying of these leaves. Within a week from this time, the whole plant may wilt and die. If such a plant be examined it will be noticed that the woody regions of the stem and leaf stalks are blackened and dead. This can be seen by cutting the stem or leaf stalk

across, or peeling back the bark. The leaves may not show the characteristic yellowing; but the blackened woody region in the stem is an unfailing symptom in all cases examined. The disease often spreads rapidly over a patch, so that in a week or two after the first symptoms appear, the whole patch may be blighted and dead. The fruit remains on the stalk and ripens prematurely, in which condition it is worthless.

Blight, more properly called "wilt," appears to be caused by a fungus, *Fusarium sp.*, which seems to enter through the roots, and

FIG. 2.—NEAR VIEW OF TWO BLIGHTED PLANTS IN FIELD SHOWN IN FIG 1.

work its way up through the woody parts of the stem until it reaches the topmost leaves and twigs. It would seem to one observing the rapid spread of the disease through a patch that it was communicated from one plant to another through the air. Such is probably not the case. It seems to be a soil infection. In many cases a healthy patch is found in the same field with a blighted one; and it has been seen in more than one patch where a part only was blighted, sometimes one end of the patch, and sometimes one side only. (See Fig. 6.) It was always found in such cases that the blighted portion was on old tomato land where blight had existed before, and the healthy portion was on new tomato land. Often only a few plants with the symptoms of blight are found in a field, and it does not seem

to spread. If the same field is put in tomatoes the following year, blight is almost certain to be more prevalent than before.

Investigation of the blight

Complaints have been reaching the Station for a number of years concerning blight in several sections of the State. In July, 1910, the Station decided to take the matter up in a systematic way and investigate it with a view of determining the cause, and

FIG. 3.—A PLANT IN THE WILT STAGE OF BLIGHT.

The plant is still alive, but is rapidly dying. This picture was made about three days after the first appearance of blight in the plant.—Field of J. G. Chandler, June, 1911.

finding a remedy, if possible. The writer of this article was assigned to that work. Gibson County seemed to be the section most in need of attention. A visit was made to that county in July and August, 1910. Many blighted fields were studied in the neighborhood of the

towns of Humboldt and Gibson, and a large quantity of material was collected for study. It was soon seen, as was expected from the work of others, that "blight" is a wilt disease probably caused by the fungus *Fusarium*. Pure cultures of a *Fusarium* were obtained from a number of blighted plants and have been grown in the laboratory for over a year. In the summer of 1911, the same fungus was again found in connection with blight. Further than this, the life-history of the fungus has not been worked out, but it is now being worked out in the laboratory, and other experiments are being inaugurated to show whether this fungus is the cause of the blight. This

FIG. 4.—A RESISTANT PLANT IN A BLIGHT FIELD.

Seed were collected from this plant for the resistance test described elsewhere. Selection No. 7 was made in this field.—Photographed July 15, 1910.

part of the work will be published in a bulletin as soon as finished.

This disease has been found in several other parts of the State. It was observed at Cleveland and Nashville in July, 1911. There is not much doubt that it is widely scattered over this State, as well as other States.

Selection for resistance

After a survey of the situation it was decided to select for resistance to blight. In nearly all blighted fields, a few plants were seen which appeared free from disease. Several plants were selected in six different fields. From these, 20 collections of seed were made, some from one plant (Fig. 4), or even from one fruit, and some from several plants thrown together as a general selection. In the spring of 1911, three plots of one-half acre each were

chosen on which to test the blight-resisting power of these selections. One plot was taken on the West Tennessee Experiment Station, at Jackson, and the other two were taken in the neighborhood of Gibson, in Gibson County. One of these was on the farm of Mr. F. W. Pillow, one mile north of Gibson, and the other on the farm of Mr. J. T. Warmath, rented by Mr. J. G. Chandler, two miles south of Gibson. No blight was known ever to have existed on the Jackson farm. Both

FIG. 5.—A RESISTANT PLANT IN A CHECK ROW.

Pillow Farm Plot, July 27, 1911.

plots near Gibson were on land where the tomato crop had been ruined by blight in 1910. The plot on the Pillow farm was on the same ground as the patch from which selections were made. (See Figs. 1 and 2.) The seed was sown in the greenhouse of the West Tennessee Experiment Station, and the plants were kept there till they were ready to go into dirt bands. They were then put out in cold-frames in the ordinary way near the plots where they were to be grown. Along with the select seed were sown seed bought in the

market. Plants from these were to be planted out in alternate rows with the selections, and were to serve as checks. Four commercial types were chosen for the checks—"Beauty," "Imperial," "Trucker's Favorite" and "Trucker's Delight." They were arranged so that each selection and each check type would appear in more than one section of the plot. The plants were cultivated in the ordinary way, pruned and tied up.

Blight appeared in some of the selections and in the check rows in both of the plots near Gibson in June. No blight appeared in the Jackson plot during the season. In the Gibson plots, it progressed rapidly in the check rows and some of the selections, very slightly

FIG. 6.—COMPARISON OF CROPS ON OLD TOMATO LAND AND NEW LAND.

The rows on the left are on land cultivated in tomatoes the preceding year. Those on the right are on land never before cultivated. This shows the need of crop rotation in tomato growing.—Field of J. G. Chandler, June, 1911.

in other selections, and in one selection was almost absent. This selection, No. 7, appeared three times in different parts of each plot. (Fig. 7.) It was remarkably free from blight till after the crop was harvested. Finally, when the plants were old and weakened by bearing and drought, they gave way to some extent and showed some of the symptoms of blight. The resistance shown by this selection was so remarkable that it almost amounted to immunity.

Results

All the check rows died rapidly after blight made its appearance. The type known as "Trucker's Delight" showed more resistance than the others. The "Beauty" check rows showed least resistance of all. Several selections also went down rapidly with blight.

Besides No. 7, Nos. 3, 12, and 13 showed considerable resistance. No. 14, which was probably a "Globe," accidentally collected, showed almost as much resistance as No. 7. Nos. 16 and 17 were selected for "Beauty," but had the bright red color of "Stone," and with No. 14 were thrown out of the experiment. The behavior of the different numbers in the two patches was very similar.

A resistant strain

No. 7 is a vigorous bearer of a well-formed fruit of the desirable "Beauty" type. The remarkable resistance of this selection strengthens the hope that a blight-resisting type can be bred up by further selection and cultivation that will solve the blight problem. A large quantity of seed was collected for the continuance of the experiment in 1912. It is planned to make selections of other types,

FIG 7.—COMPARISON OF PLANTS FROM SELECT AND COMMERCIAL SEED.

The row on the left is a selection (No 7). The row on the right is a check row of "Beauty."—Pillow patch, July 20, 1911.

particularly of the "Trucker's Favorite." This is a desirable variety favored by a large number of growers, but unfortunately subject to blight.

One type of tomato, the "Globe," which has been tried to a considerable extent, seems to be naturally resistant. Its shape is not good, however, and it does not pack well. It lacks the favorable color and flavor of the "Beauty." It is probable that a desirable variety of "Globe" could be selected and propagated.

There is probably as much to be gained by a system of crop rotation as by the planting of resistant strains. The land is often planted to tomatoes year after year without intermission. It is in farms of this character that blight does the greatest damage. It is believed that with such a system of rotation, and careful and clean cultivation, the soil could be freed from blight and restored to its original productiveness.

CONCLUSIONS

1. Tomato blight as known in the West Tennessee trucking region, is a specific disease probably caused by a fungus, *Fusarium sp.*

2. The blight fungus remains in the soil over winter and starts the infection in the new crop next year through the roots.

3. Blight is communicated very slightly, if at all, through the air.

4. Blight may be communicated to new fields through plants brought from infected districts or grown in infected beds; through the use of old tomato stakes or manure from hay grown in blight-infected fields, or soil transferred on farming implements.

5. Blight cannot be controlled by sprays.

6. Certain types of tomatoes are naturally resistant to blight.

7. Some individuals of all types are resistant, and this character is transmitted to succeeding generations.

8. It is perhaps possible by selection and cultivation to breed up a resistant strain of any desirable type.

RECOMMENDATIONS TO TOMATO GROWERS

1. Do not put tomatoes on land where blight has existed within three years past.

2. Do not use old beds or frames or the same soil from which it is suspected blight has come.

3. In constructing new beds, do not use material from old beds, or soil from blighted fields, or soil from places which may have received the wash from blighted fields.

4. Do not use manure from stables where hay from blight fields has been used.

5. Do not use stakes from blight fields, or transfer soil from blight land on farm implements.

6. Take every precaution to prevent the infection of new beds and fields.

7. Save seed from the healthiest and most desirable individuals instead of depending on the market for seed from other localities.

8. Practice a system of crop rotation in which tomatoes will not appear oftener than once in four years.

9. Disinfect all old stakes by painting them with a strong solution of copper sulphate and water.

The Experiment Station wishes to express its appreciation to citizens in the vicinity of Gibson for their help and co-operation. Especially are thanks due to Mr. F. W. Pillow and Mr. J. G. Chandler, to whose assistance the success of the experiment thus far is largely due. The plots were cultivated under their immediate supervision and advice.